REPORT NO. CG-D-60-79

SAN FRANCISCO VESSEL TRAFFIC SERVICE WATCHSTANDER ANALYSIS

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U.S. DEPARTMENT OF TRANSPORTATION
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
Transportation Systems Center
Cambridge MA 02142

NOVEMBER 1979

INTERIM REPORT

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD
Office of Research and Development
Washington DC 20590

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
USCG-D-60-79		

4. Title and Subtitle
SAN FRANCISCO VESSEL TRAFFIC SERVICE WATCHSTANDER ANALYSIS

5. Report Date
Nov[illegible]79

6. Performing Organization Code

7. Author(s) J.W. Royal, D.B. Devoe, C.N. Abernethy, K.S. Kearns, R.A. Rudich

8. Performing Organization Report No.
DOT-TSC-USCG-79-4

9. Performing Organization Name and Address
U.S. Department of Transportation
Research and Special Programs Administration
Transportation Systems Center
Cambridge MA 02142

10. Work Unit No. (TRAIS)
CG913/R0002

11. Contract or Grant No.

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
U.S. Coast Guard
Office of Research and Development
Washington DC 20590

13. Type of Report and Period Covered
Interim Report,
Apr. 77-Sep 78

14. Sponsoring Agency Code

15. Supplementary Notes
79

16. Abstract

A team of human factors specialists analyzed the performance of watchstanders in the U.S. Coast Guard's San Francisco Vessel Traffic Center at Yerba Buena Island, San Francisco, California. Data collected included copies of the center's forms and logs, records and tapes of watchstander activities for a total of 10 hours of observation, records of 9 in-depth interviews with operations personnel, stress questionnaires and critical incident interviews from 12 watchstanders, and photographs of equipment and workspace layout. Analysis of the data yielded a breakdown of watchstander time utilization, a summary of communications loading, and data for a tentative model of watchstander activity as a function of traffic and communications loads. Seven suggestions for improving operations were offered.

17. Key Words	18. Distribution Statement
Vessel Traffic Service Traffic Management Watchstander Performance Human Factors	DOCUMENT IS AVAILABLE TO THE PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161

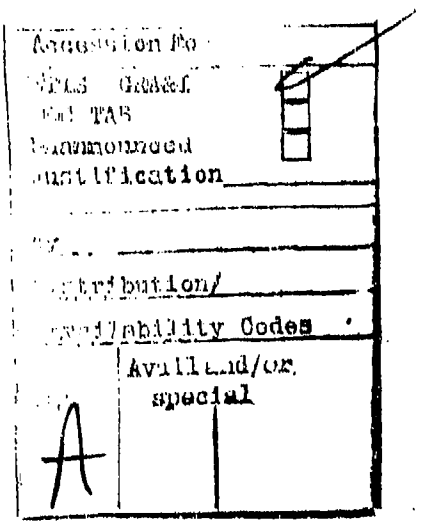
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	82	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

PREFACE

This is an interim report on the analysis of watchstander activities at the San Francisco Vessel Traffic Service. The study was performed by the Behavioral Systems Branch of the Department of Transportation, Transportation Systems Center (TSC) under the sponsorship of the U.S. Coast Guard, Office of Research and Development.

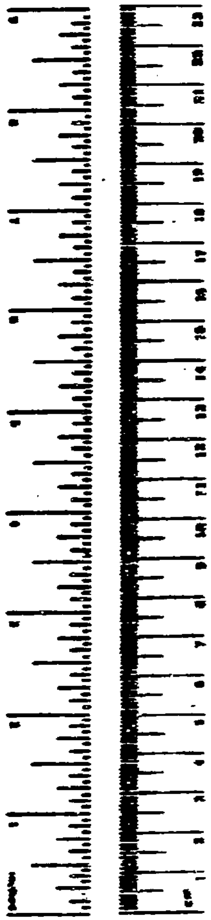
The authors wish to express their sincere appreciation to Loren B. Kelley, Lt. P.R. Corpuz and LCDR C.T. Johnson (now retired) of the Office of Research and Development and to Capt. R.A. Johnson and all the personnel of the San Francisco Vessel Traffic Service for their encouragement and support throughout this study. We also gratefully acknowledge the guidance and contributions to this report provided by Dr. H.P. Bishop, Program Manager and Chief, Behavioral Systems Branch (DTS-532) at TSC.



METRIC CONVERSION FACTORS

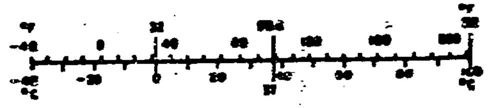
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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ABBREVIATIONS

COTP	-	Captain of the Port
CPO	-	Chief Petty Officer
MSO	-	Marine Safety Office
PPI	-	Plan Position Indicator
SAR	-	Search and Rescue
SFVTS	-	San Francisco Vessel Traffic Service
TSC	-	Transportation Systems Center
TSS	-	Traffic Separation Scheme
USCG	-	United States Coast Guard
VMRS	-	Vessel Movement Reporting System
VTC	-	Vessel Traffic Center
VTS	-	Vessel Traffic Service

EXECUTIVE SUMMARY

In this, the fourth study in a program for the evaluation of watchstander productivity in U.S. Coast Guard maintained Vessel Traffic Services (VTS), a team of human factors specialists from the Department of Transportation, Transportation Systems Center (TSC) collected and analyzed data on watchstander activities at the San Francisco Vessel Traffic Service (SFVTS). During the period July 10-13, 1978, the following information was obtained:

Copies of VTS forms and logs.

Detailed records of watchstander activities for a total of 10 hours of observation.

Tape recordings of Channel 13 radio communications between VTS and vessels.

Records of nine in-depth interviews with VTS personnel.

Records of 11 stress questionnaires and critical incident interviews.

Photographs of equipment and workspace layout.

The SFVTS area is a single-sector operation, although there are two distinct sections in the entire system. The major area encompasses San Francisco Bay and about 12 miles beyond the Golden Gate Bridge. Most of this area is under continual radar surveillance. From San Pablo Bay, in the northern section of the San Francisco Bay complex, up the Sacramento and San Joaquin Rivers to Sacramento and Stockton, the VTS maintains a vessel movement reporting system (VMRS) with no radar coverage at all. Although the entire system is voluntary, there is virtually complete participation by all vessels subject to the Bridge-to-Bridge Radiotelephone Act. Under routine conditions, the complete VTS area is monitored by a single watchstander tracking vessels on five radar displays and a river status board.

At the time of this study there were from 5 to 12 vessels participating in the system at any given time. Watchstanders communicated with these vessels an average of 20.1 times per hour with a mean of 20.9 seconds per communication. When all of the watchstanders' activities were combined the following time allocations per activity were derived:

Activity	Amount of Duty Time
Monitoring	45.0%
Radio Communications	11.6%
Other Job-related Activities	21.9%
Non-Job-related Activities	21.5%
Total	100.0%

The major findings of the interviews and stress questionnaires indicated that the watch personnel are relatively satisfied with the current operations and equipment at SFVTS. Most of the complaints and suggested changes were minor and oriented toward improving the quality of the service, ease of operation, and the morale of the watchstanders. The overwhelming majority of complaints about the system referred to the boredom felt by the watchstanders, especially during their break periods. The prevalent stress responses of drowsiness and tiredness also relate, at least partially, to this lack of challenge in the work. Many watchstanders complained of eye irritation which could have been exacerbated by problems in illumination, inadequate ventilation, or the long, 12-hour watch schedule.

The recommendations resulting from this study are as follows:

1. Study the efficacy of the present work schedule
2. Improve heating, cooling, and air circulation
3. Explore methods for light-shielding the radars
4. Standardize SOP for all watch sections
5. Re-evaluate training procedures

6. Continue and expand career training programs

7. Study the effects of rearranging radars in an arc around the central watchstander position.

1. INTRODUCTION

1.1 PURPOSE

In order to reduce the probability of vessel collisions and groundings in crowded waterways and to keep individual vessels apprised of the total traffic situation, the U.S. Coast Guard has been charged with establishing and operating several vessel traffic services (VTS's). To profit from the experience gained in operating these VTS's, both to improve present services and to plan future services, the Coast Guard's Office of Research and Development has undertaken a broad program of analysis of VTS operations.

Human performance is basic to the operation of a VTS. The principal product of a VTS is a traffic advisory communicated by a VTS watchstander to a vessel master or pilot via VHF-FM radio. The value of an advisory is dependent upon the skills of the various watchstanders in acquiring and monitoring traffic data; in integrating the data into a coherent picture of present and anticipated traffic; and in composing and delivering a clear, concise, and accurate traffic advisory. Therefore, the Coast Guard has recognized that any model of VTS operations and productivity must include the influence of watchstander performance on system performance. The Coast Guard's Office of Research and Development has commissioned the Behavioral Systems Branch of the Department Transportation's Transportation Systems Center (TSC) to obtain and analyze data on watchstander performance and to integrate the results into models of watchstander activity and productivity.

1.2 SCOPE

This report is the fourth in a series of interim reports on four operational VTS's: Houston-Galveston, Puget Sound, New Orleans and San Francisco. The analyses are restricted to events occurring during routine operations at the SFVTS. Watchstanders were observed and data recorded over a week representing usual and routine circumstances. Watchstander activities, radio communication

and vessel traffic were examined in order to evaluate watchstander productivity as a function of workload.

2. DESCRIPTION OF SAN FRANCISCO VESSEL TRAFFIC SERVICE

2.1 PURPOSE OF VTS

The Ports and Waterways Safety Act of 1972 authorizes the Coast Guard to establish and operate VTS's in designated areas to "...prevent collisions and groundings and to protect navigable waters of the VTS area from environmental harm resulting from collisions and groundings."* Vessel traffic services meet this objective by "Traffic separation..., the relay of navigational safety information collected by the Vessel Traffic Center to the masters or others in charge of navigation of vessels, and the encouragement of mutual planning via bridge-to-bridge radiotelephone."**

2.2 GENERAL CHARACTERISTICS OF SAN FRANCISCO VTS

The San Francisco Vessel Traffic Service (SFVTS), the first Coast Guard operated VTS, is located on Yerba Buena Island in San Francisco Bay and provides an all-weather, 24-hour service to vessels navigating the Greater San Francisco Bay complex. Included in the major area of coverage is the San Francisco Bay, the bay tributaries north to Sacramento and east to Stockton, and several miles of the seaward approach to the bay. The SFVTS carries out its mission through the use of a traffic separation scheme (TSS) and a communications/surveillance network.*** The radar coverage area of the SFVTS is shown in Figure 2-1.

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*Code of Federal Regulations, 33 CFR161.101.

**San Francisco VTS Operating Procedures, 1973, p.1.

***Unless otherwise specified, the descriptive material in this report comes from the following sources:
SFVTS Operating Procedures, March 1973
SFVTS Traffic Center Manual, April 1974.

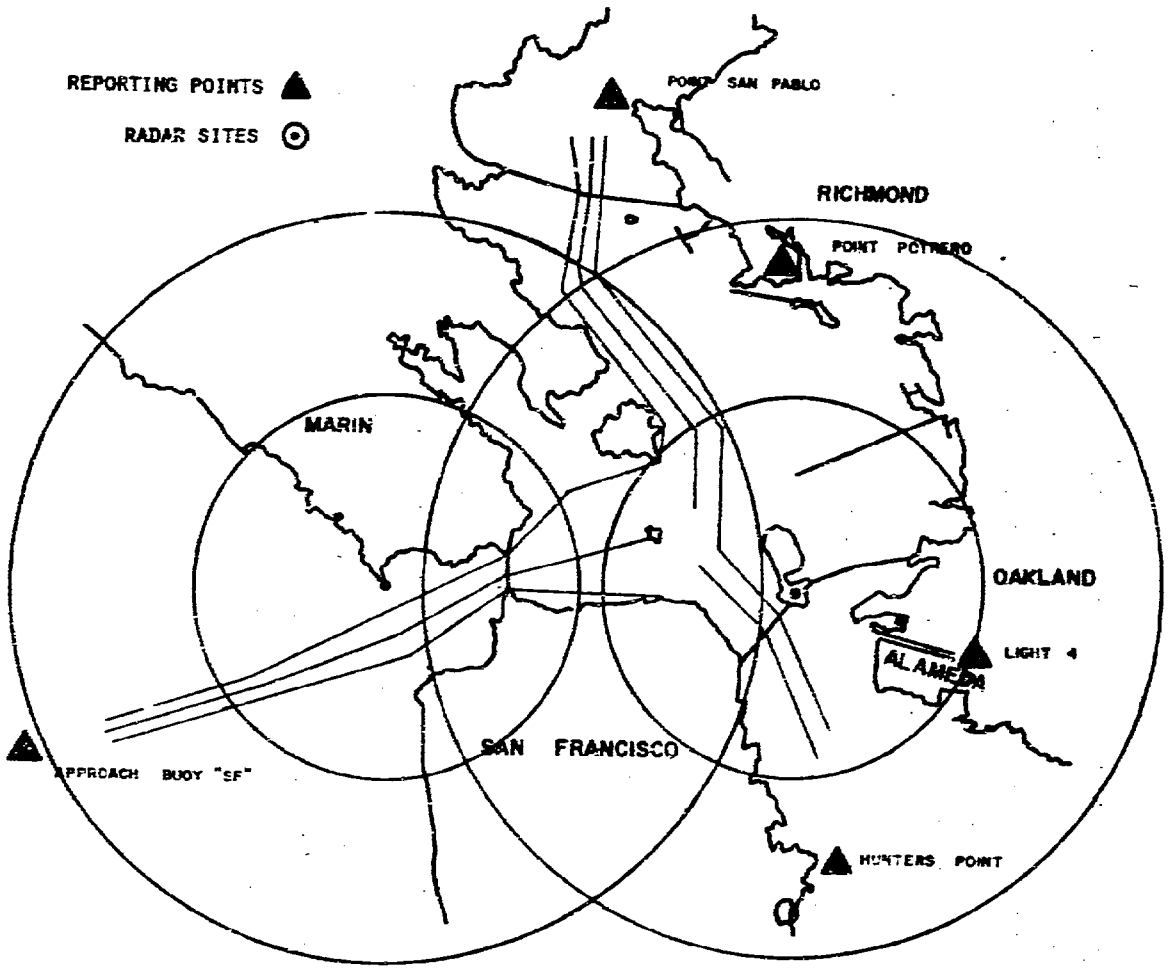

FIGURE 2-1. RADAR COVERAGE AREA OF SFVTS INCLUDING REPORTING POINTS, RADAR SITES, AND TSS

The TSS, with its vessel traffic lanes, precautionary area, and limited traffic area, was established to minimize conflicting traffic situations and to create a standard transit procedure. The vessel traffic lanes constrain certain types of vessels moving in a given direction to well defined areas, separated from opposing traffic. In the relatively fog and obstruction free area east of Alcatraz Island, the traffic lanes converge to form the precautionary area. Here, subject to the exercise of special caution, vessels may cross opposing traffic lanes and join divergent ones. The limited traffic area is located in the Oakland Bar Channel where the channel is too narrow to permit opposing traffic lanes. Generally, only traffic moving in one direction is permitted at any given time. Participation in the TSS is voluntary and vessels may digress subject to arranging safe crossings with potentially conflicting traffic.

A radar surveillance network, a vessel movement reporting system (VMRS), and a VHF-FM radiotelephone system are the component parts of the communications/surveillance system. The radar system provides a direct visual display of the traffic situation within its area of coverage. The VMRS establishes the traffic situation in the area beyond radar range by having vessels report passing selected geographic points. The communication system provides the means for exchange of information between vessels and the vessel traffic center (VTC).

2.3 FUNCTIONS

The SFVTS is based on a voluntary VMRS backed up by high-resolution radar surveillance for most of the bay area. Vessels call the VTC to report their name, position, and intentions; the center responds by recording the information and issuing an advisory on encounters and environmental conditions that the vessel may expect. So, the basic functions involved in the operation are the vessels' reporting to the VTC and the center's monitoring the traffic and issuing advisories.

2.3.1 Vessel Reporting

All vessels subject to bridge-to-bridge radio-telephone regulations and planning to operate within SFVTS boundaries are encouraged to participate in the service.* The Coast Guard recommends that vessels entering the radar surveillance area or departing from a berth or anchorage within the area report to the VTS giving their identity, destination, route and any other information necessary to assure safe transit through the system. Vessels call in the information on Channel 13, the VTS working channel, and, thereafter, maintain a constant watch on that channel for VTS communications. The established entry identification reporting points include: the San Francisco Approach Lighted Horn Buoy "SF", Hunters Point, Oakland Inner Harbor Light No. 4, Point Potrero in Richmond Harbor, and Point San Pablo, although vessels usually report in prior to reaching these points (Fig. 2-1). Within the river area there are additional specified check points where vessels are requested to report when passing in order to assist the VTS in establishing an accurate traffic pattern for those waterways.

2.3.2 Monitoring

Monitoring involves creating and maintaining as accurate a picture of the current traffic situation as available data permit. Within the radar surveillance area, this is accomplished by identifying and tracking vessel radar contacts displayed on the PPI. Vessel movements in the river area are monitored via a voluntary checkpoint reporting system and represented in the center by vessel cards placed on the river status board. An approximating system of dead reckoning is used in conjunction with vessel reports to update positioning of the cards.

*Unless otherwise specified, reference to vessels or traffic throughout this report includes only those vessels subject to bridge-to-bridge radiotelephone regulations.

2.3.3 Advising

Information on vessel movement (identity, route, destination, etc.) and current position is the fundamental product of the VTS. This information, in the form of an advisory, is provided to a vessel via Channel 13 upon its specific requests or at the initiative of the watchstander if he has information of particular relevance. Advisories are of three basic types: A general status advisory, advisory with a recommendation, and a direct order.

Generally, an advisory includes the nature, position, direction, and route or destination of conflicting traffic. Information on weather, visibility, problems with aids to navigation, recreational traffic, and other conditions affecting a safe transit may be included, if necessary.

In addition to providing specific and general information, an advisory may include a recommendation for action. This type of advisory is issued when a watchstander detects potentially conflicting traffic or a digression from traffic lane discipline. For example, the watchstander may recommend a specific action to the subject vessel and suggest that conflicting vessels arrange a mutually agreeable passing as an alternative. In situations of imminent hazard, mandatory directives may be issued by the VTC from the watch officer in charge, acting with the authority of the Captain of the Port (COTP). Otherwise, compliance in the VTS is strictly voluntary.

Examples of advisories representing the three types are: 1) "ZENLEN GLORY this is TRAFFIC, the KYUSHO MARU with UNIT FIFTEEN aboard passing Blossom Rock, northbound, over." 2) "...this is TRAFFIC, TEXAS TRADER with UNIT CHARLIE aboard passing Mile Rock; recommend you follow outbound traffic lane north of Alcatraz or arrange safe passing with UNIT CHARLIE, over." 3) "...this is TRAFFIC, the Coast Guard Captain of the Port ordered the Oakland Inner Harbor Estuary from Marker #4 to Grove Street closed to all vessel traffic until further notice, over."

2.3.4 Additional Functions

In addition to these basic traffic service functions, the VTS has been delegated the authority to control the use of anchorages, under the general supervision of the COTP. The VTS also relays messages among Coast Guard units, vessels, and onshore installations when it does not interfere with primary functions.

To facilitate the performance of the VTS mission, watchstanders must also perform various support functions including training and preparation and dissemination of records, reports, and messages.

2.4 STAFFING AND SCHEDULING

2.4.1 General Staffing

At the time of this study, the SFVTS had the following complement of 30 operational personnel, 7 officers and 23 enlisted:

1 - CDR - Comanding Officer

6 - Lt. - 1 Executive Officer, 5 Watch Officers

1 - RDCS - Watch CPO*

2 - QMC - Watch CPO's

2 - RDC - Watch CPO's

4 - QM1 - Watchstanders

2 - RD1 - 1 Watchstander, 1 Administrative Assistant (DWPO)

4 - QM2 - Watchstanders

3 - RD2 - Watchstanders

1 - QM3 - Watchstander

1 - RD3 - Watchstander

1 - YN2 - Administration

*CPO - Chief Petty Officer, Enlisted pay grade E-7, E-8, or E-9.

1 - ET3 - ET Shop

1 - SN - Duty Seaman.

These billets are divided into five watch sections comprising at least one watch officer, one watch supervisor (CPO), and two watchstanders. Additional dayworkers and trainees are assigned as appropriate.

2.4.2 Selection

Full lieutenants with seagoing experience as operations officer on a high or medium endurance cutter, commanding officer of a patrol boat, or executive officer of buoy tender, serve as watch supervisors. Anyone with average or above average proficiency and due for a shore assignment may be selected for VTS duty, although consideration is given to those who volunteer for the assignment. All VTS watchstander assignments have been made from radarman (RD) and quartermaster (QM) ratings. A normal tour of duty is three years.

2.4.3 Training

Before a trainee can be certified as a watchstander he must have completed a comprehensive training program and at least six months of VTS duty. The qualification procedure does not contain classroom instruction because there are no scheduled times when new trainees arrive. Whenever a trainee does report to the VTS he is assigned to a watch section and the watch officer for that section supervises the training.

The qualification procedure is divided into four phases. In Phase I trainees are required to study written materials pertaining to VTS background, SOP, and regulations and to become familiar with the operations of equipment at the center. When a trainee feels that he is competent in these subjects he requests an examination from his watch officer. After successful performance on the examination, the trainee advances to Phase II.

During Phase II the trainee reads documents describing the functions of 17 shore-side facilities which relate to his future duties as a VTS watchstander. He then visits each site in order to meet the personnel and observe operations. Concurrently, the watch officer or watch supervisor arranges for the trainee to make 24 shiprides which insure that the trainee:

a) sees the entire VTS area

b) becomes familiar with the type of vessels that use the service

c) understands the specific needs and problems of the masters and pilots in navigating under all conditions.

Phase III is designed to give the trainee a more diverse perspective of VTS watchstanding techniques. To accomplish this, the trainee must spend at least one watch with each of the other sections.

In Phase IV of qualification a final examination is administered by the senior watch officer covering the entire scope of the training. When the senior watch officer is satisfied that the trainee is qualified, he will recommend to the commanding officer that the individual be certified as a VTS watchstander.

Every fifth week during operations and after qualification, the entire watch section is assigned a day shift for refresher training. This time may be spent in refresher ship rides (one per quarter), other VTS-related training, or on personal career advancement training.

2.4.4 Work Schedule

There is a complex rotation of the five watch sections through the watch shifts and days off. (See Table 2-1.) The watch shift is 12 hours long; the day shift runs from 0700 to 1900 hours followed by the night shift, from 1900 to 0700 hours. The relieving shift is expected to report to the center 15 minutes prior to their watch to familiarize themselves with

TABLE 2-1. EXAMPLE OF WATCH SCHEDULE FOR SFVTS. DATA ARE FOR FIVE WATCH SECTIONS (A,B,C,D, AND E)

		TIME OF WORK SHIFT		
Date	Day	0700-1900 HRS	1900-0700 HRS	Dayworking
1	S	D	A	B
2	SU	D	A	
3	M	B	E	C
4	T	B	E	
5	W	A	D	
6	TH	A	D	
7	F	E	B	
8	S	E	B	
9	SU	E	B	
10	M	C	A	D
11	T	C	A	
12	W	B	E	
13	TH	B	E	
14	F	A	C	
15	S	A	C	
16	SU	A	C	
17	M	D	B	E
18	T	D	B	
19	W	C	A	
20	TH	C	A	
21	F	B	D	
22	S	B	D	
23	SU	B	D	
24	M	E	C	A
25	T	E	C	
26	W	D	B	
27	TH	D	B	
28	F	C	E	
29	S	C	E	
30	SU	C	E	
31	M	A	D	B

the traffic situation. A given watch section will alternate between a period of two or three day shifts and a period of two or three night shifts with 48 to 84 hours off between changes. Every fifth week they will be assigned as day workers on 8-hour shifts. During a watch, a watchstander will rotate positions after 2 hours of radar monitoring or at the discretion of the watch officer.

2.4.5 Career Training

At SFVTS, there is an official policy to provide incentive and opportunity for all personnel, both officers and enlisted men, to pursue training and education in their rate. During break time while on duty and especially during the week of refresher training, VTS personnel are encouraged to participate in either independent or group training/education to further their Coast Guard career. Occassionally, this may include several weeks of training at a nearby facility.

2.5 OPERATING POSITIONS

2.5.1 Watch Officer

The watch officer is directly responsible for the performance of the watch and the conduct of the personnel assigned to his watch section. This position is always manned by a commissioned officer; he is the direct representative of the commanding officer and in emergency situations he may exercise the traffic control authority of the COTP. The primary duty of the watch officer is to supervise all activities of the VTS during his watch. He assigns personnel to the various operating positions, supervises their performance, and rotates assignments as circumstances require. Situations beyond the scope of control of the watchstanders are referred to the watch officer, who, in turn, notifies the commanding officer or other authorities on matters beyond his scope of control. Other responsibilities of the watch officer include: regulation of anchorage use, internal unit safety, physical security, training of watch section personnel, drafting

and dissemination of messages, reporting violations of regulations, and overseeing the maintenance of long term records. Additionally, the watch officer may, at his option, stand watch at the radar display position.

2.5.2 Watch Supervisor

The watch supervisor is a CPO whose duties are similar to those of the watch officer. He assists in training new watchstanders and supervises the operation of a watch in the watch officer's absence.

2.5.3 Watchstander

The watchstander is responsible for the conduct of VTS functions (i.e., to monitor, anticipate, and advise) for all of the traffic within the system. He is seated at the display operating position where he monitors the five radar displays and Channel 13 on the VHF-FM radio. Radio contact is established with every vessel entering the system and the watchstander requests information regarding the vessel's name, pilot identifier, type, position, draft, destination, route, and any other information he feels pertinent. He then records this information on a vessel data card on a counter in front of him. If the vessel is in the river area he affixes it with a magnet to the appropriate position on the river status board. Using the information on the cards in conjunction with that gathered from the communications/surveillance network, the watchstander mentally formulates the present and future traffic pattern. As vessels update their positions, the location and time are entered on the data cards and compared with the displays. When the river status board requires updating, the card is moved to the new position. Upon a vessel's request or in anticipation of a traffic conflict, the watchstander will issue an advisory to the appropriate vessel.

Under normal circumstances the VTS area is not sectorized, so the radar displays and the VMRS status board are manned by a single watchstander. The remaining watch personnel are

constructively employed in the center standing ready for rotation into the duty position. Duty rotations occur approximately every 2 hours. If heavy traffic or unusual circumstances warrant, the watch officer or supervisor may sectorize the VTS area and have two watchstanders maintain the system.

2.6 EQUIPMENT AND WORKSPACE

2.6.1 VHF-FM Radio and Communications

The SFVTS communications system allows the VTS to communicate with all vessels in the area and, to a degree, beyond. Two remote-controlled, six-channel transceivers are installed at the Pt. Bonita radar site, Yerba Buena Island, and TV Hill. At each site one transceiver is designated "main" and the other "standby". Both are tuned for the same channels; however, the "main" transceiver operates at a reduced power of five watts and the "standby" operates at 10 watts for use when the "main" transceiver cannot maintain reliable contact. Each site is also equipped with guard receivers tuned to Channel 13 and to Channel 16 so that these channels are monitored constantly when the transceivers are switched to other channels. Supplementary transmission facilities are available by use of a "telephone patch" through the Coast Guard Group Operations Center. VTS working communications are carried out on Channel 13, the bridge-to-bridge channel, with additional capabilities on Channels, 12, 16 (maritime distress), 18A, 22, and 81. An official log of all communications is maintained by continuously recording all channels on a 20-channel tape deck.

Each operating position has a communication control system comprising a Motorola 1366 Transceiver Control, a guard receiver panel, and a headset muting panel. The position used for external communications has additional specialized controls. Included there is a takeover control panel which assigns transmitter site control to the other operating position, a Point Bonita emergency generator panel, a broadcast tape recorder, and a communications equipment alarm and control panel which has equipment status indicators and

controls for switching between main and standby transceivers at each site.

2.6.2 Radar

The radar surveillance system is based on the experimental Harbor Advisory Radar System using high-resolution, dual-channel radar to monitor the entire harbor area. The Point Bonita radar, scanning the outer harbor and seaward approach, transmits its information via microwave link to the Yerba Buena Island VTC where a second radar installation scans the inner harbor. The radar signal is adjustable in pulse length, rate, and polarization mode; providing vessel range resolution of 30 feet and bearing resolution information accurate to within ± 30 feet per nautical mile under virtually all conditions.

The radar operating position contains five AN/FPS-109 (XN-I) display consoles with 16-inch PPI's. In addition to the direct radar display, the PPI can generate six lead lines to indicate boundaries and a moveable cursor which yields numeric range and bearing readouts for any two points desired. The watchstander may select from five range scales (2, 4, 6, 8, and 16 nmi.) and off-center the display up to five radii. Controls are included on each console for the above functions and to regulate the radar pulse configuration. Typically, two PPI's are set to display the pilot station and bay area as "seen" by the Point Bonita radar. The remaining three displays monitor the bay area, southern bay, and Oakland Harbor ranges of the Yerba Buena radar. Figure 2-2 shows the watchstanders' duty position centered on the five radar displays.

2.6.3 VMRS Area

The bay tributaries leading north to Sacramento and east to Stockton are beyond the range of radar coverage, but are within the service area. The VMRS in these waters provides radio monitoring of vessel locations and intentions. Vessels report their position upon entering the area and are requested to acknowledge

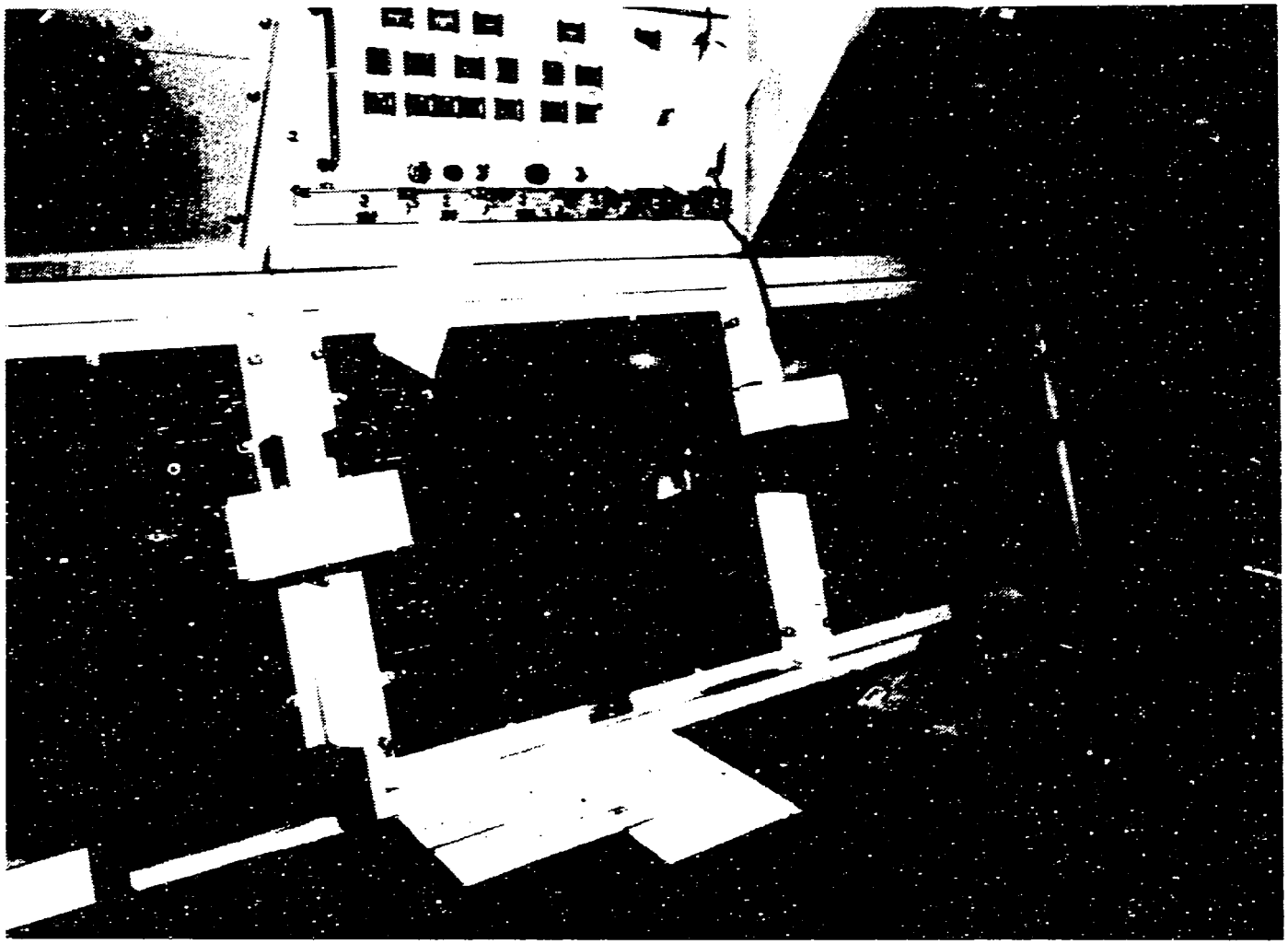

FIGURE 2-2. PRIMARY WATCHSTANDER DUTY POSITION AT CENTER RADAR DISPLAY

passing specified checkpoints along their route. The reported positions and times are recorded on a vessel data card and, based on this information, the watchstander affixes the data card with a magnet to a position on the river status board. The river status board (Figure 2-3), located above the radar display operating position, is a graphic representation of the traffic lanes in the VMRS river area with the locations of the reporting points marked. The data cards are moved along by the watchstander as the vessels update their position and by dead reckoning of a vessel's movement.

2.6.4 Vessel Data Cards

The vessel data cards are the primary means of recording information requiring immediate access for each vessel in transit within the system. The format of the data cards is illustrated in Figure 2-4. During a vessel's initial communication, the watchstander will fill in vessel name, pilot identifier, draft, date, vessel code, and any pertinent remarks in the appropriate spaces on the card. He then writes the entry position and time in the upper left of the spaces provided and places the card in front of him or on the river status board depending on where the vessel is operating. If the vessel entered is a freighter or tanker, the watchstander telephones the marine safety office (MSO) to inform them of the vessel's situation. The time of the call is entered in the "remarks" section of the vessel card (see Fig. 2-4). Supplemental position reports are entered in the same manner when they are made. If a vessel deviates from the traffic lanes, watchstanders are required to write in red ink the time and location of the deviation. When a vessel reaches a berth or an anchorage or exits the system, the final position and time are entered in the lower right space and the card is placed in an out box. For vessels making multiple trips, the appropriate box is checked and each one-way trip recorded with the card being stored in a console slot between trips. The completed cards are collected at the end of each day and used to compile the operations summary for permanent record.

FIGURE 2-3. RIVER STATUS BOARD

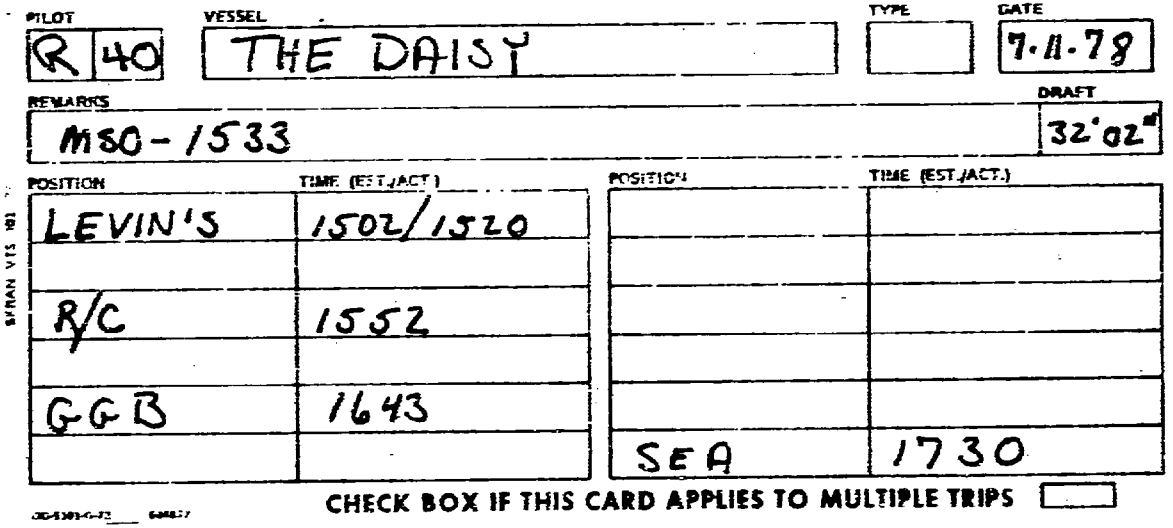

FIGURE 2-4. EXAMPLE OF VESSEL DATA CARD

2.6.5 Work:pace Layout

The layout of the SFVTS operations room is shown in Figure 2-5. The watchstander is generally positioned facing the central of five radar displays (Radar 3, in the figure) which provides a radar image of the central to north area of San Francisco Bay. Radar 1 gives the watchstander an expanded view of the area outside the Golden Gate Bridge providing information on vessels approaching the San Francisco Approach Lighted Horn Buoy "SF." Radar 2 is used to monitor traffic between Buoy "SF" and the Golden Gate Bridge. Radar 3 is used to monitor traffic west and north of Yerba Buena Island and Radars 4 and 5, traffic in the southern portion of the bay.

The watch officer is stationed behind the watchstander so that he may monitor all radar display screens from a distance and be close to the watchstander. To the right of the radars are the external communications equipment and the controls for adjusting the radar and the radio transceiver sites. To the far left of the radar displays is a large, floor-to-ceiling vessel status board, displaying a chart of the entire VTS operating area and a listing of expected arrivals and departures, vessels in anchorage, and current weather conditions. Figures 2-6, 2-7, and 2-8 provide general views of the operations room.

2.7 EVENTS IN A ROUTINE TRANSIT

This study is limited to routine VTS operations. Following is a brief description of the sequence of events as a vessel makes a normal transit through the system.

2.7.1 Entry

A participating vessel signals its entry from outside the system or from a berth or anchorage within the system by calling the VTS. The watchstander requests information detailing the vessel's name, pilot identifier, draft, destination, and entry point. The watchstander acknowledges receipt by reading the information back to the vessel. He then enters this information along with entry time, a vessel category code, and any other

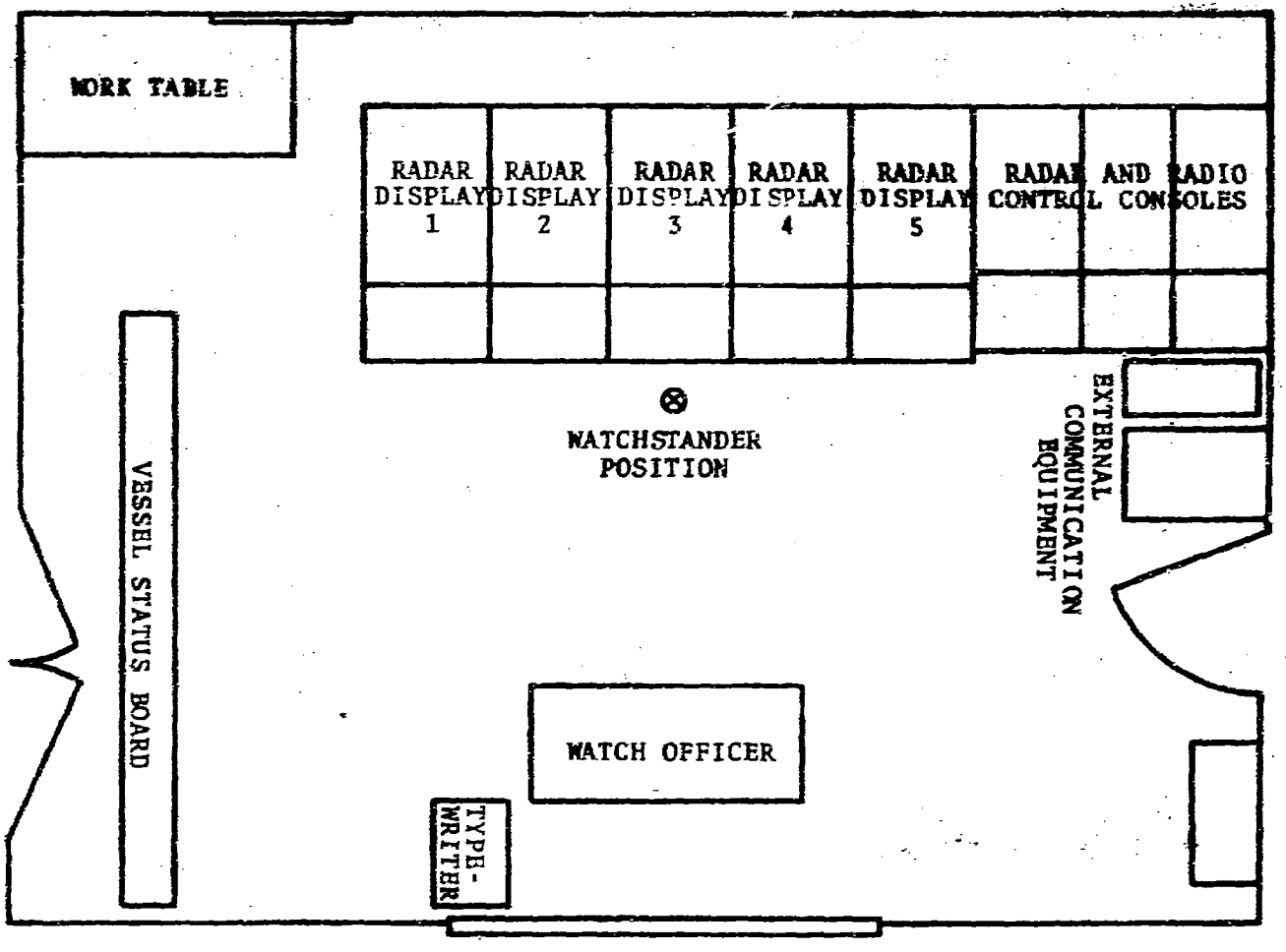

FIGURE 2-5. SFVTC WORKSPACE LAYOUT

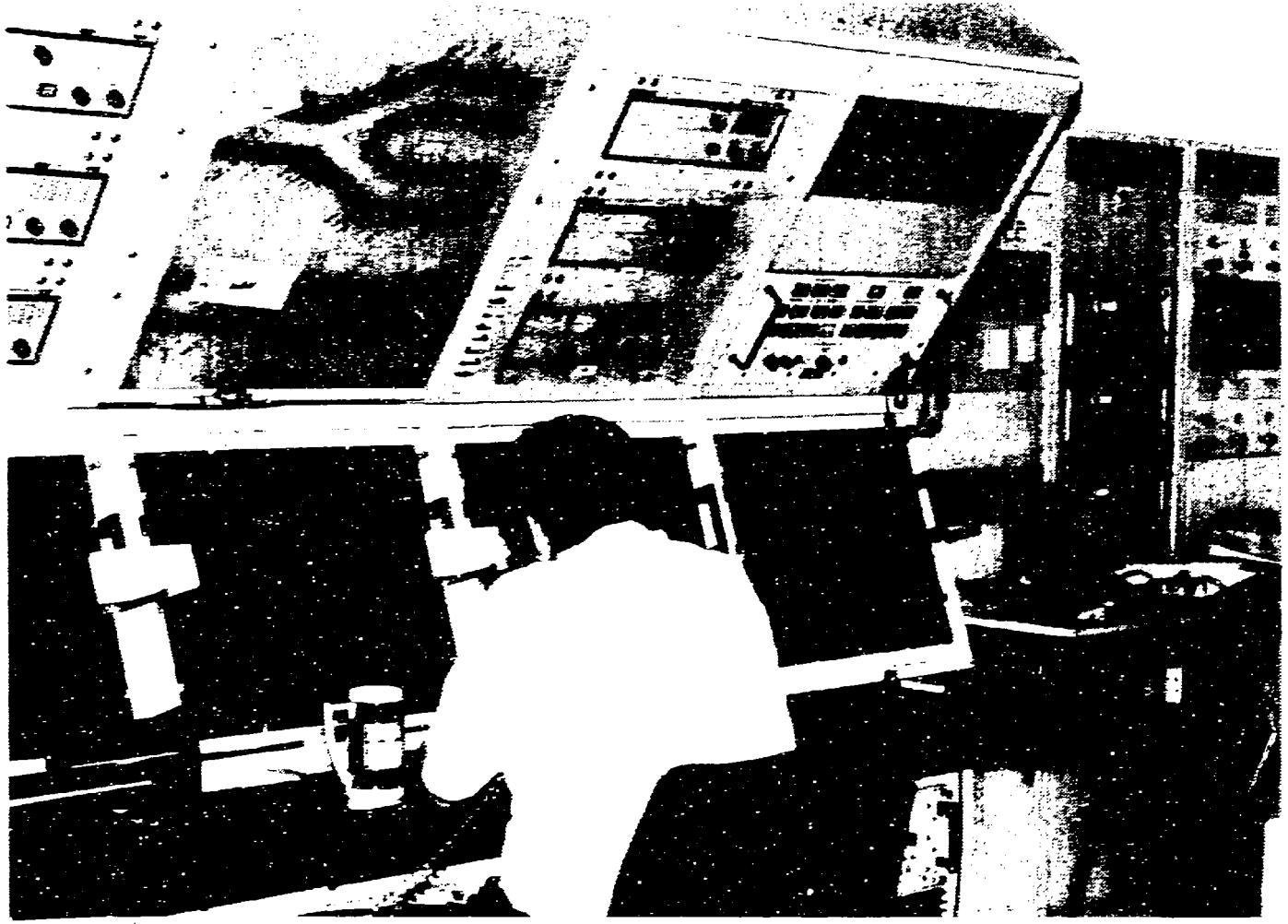

FIGURE 2-6. WATCHSTANDER AT STATION: SHOWING RADAR DISPLAYS, RIVER STATUS BOARD, AND RADAR/RADIO CONSOLES

FIGURE 2-7. OPERATIONS ROOM SHOWING RADAR DISPLAYS, WATCH OFFICER'S DESK AND VESSEL STATUS BOARD

FIGURE 2-8. VESSEL STATUS BOARD

remarks onto a vessel data card. If the vessel is within the range of the radar, the watchstander places the data card on the console in front of him and uses the information to identify the radar contact of the vessel. For vessels under way in the VMRS area, the card is affixed by magnet to the appropriate spot on the river status board. Additionally, if a vessel is bound for a berth or anchorage within the system, it will be advised of the availability of space at its destination.

2.7.2 Transit

The progress of a vessel under way in the radar surveillance area is monitored by tracking its radar return. Advisories are issued upon request of the vessel or if the impending situation warrants. The watchstander enters the location and time on the data card for any position reports the vessel may make. Further, if he detects a vessel departing from the traffic lanes, he writes the information on the vessel card denoting the vessel's new route whether the vessel reports or not. Vessels in the rivers report passing specified checkpoints which the watchstander records along with the time on the data card. The position of the card is then updated on the river status board. The status board position also may be updated by dead reckoning as the watchstander feels appropriate.

2.7.3 Exit

A watchstander monitors the progress of a vessel on the radar display until it reaches a berth or anchorage within the system or passes beyond its outer limits of the system. Vessels usually report leaving the system; however, if they do not report, the watchstander, having seen the departure on the radar, contacts them for verification. He then records the observed or reported time and location of this exit in the lower right hand box of the data card. If the card is for a multiple trip user (ferries, tour boats) the card is stored for later use. Cards for single trip users are placed in an out box to be tallied for the record of the day.

3. METHOD

3.1 SCOPE

A team of four TSC observers collected data at SFVTS from July 10 through July 13, 1978. The data collected included frequency and duration of watchstander activities, recordings of radio communications with vessels, individually administered interviews and stress questionnaires, photographic recordings of center activities, and center maintained records covering the data collection periods.

Watchstander activities were observed in order to determine the frequency and duration associated with the separate tasks included in the entire job. By breaking down the total job into its specific components it was felt that a more complete understanding of the watchstander's duties would be realized. The sample periods included 10 hours of watchstander observation distributed over the daylight hours of the week. Each sample lasted 1 hour and involved a detailed recording of the watchstander's activities along with a tape recording of that hour's radio communications on Channel 13. Five watchstanders from three different watch sections were observed. The data collection schedule is presented in Table 3-1.

Interviews, stress information, and other VTC records were obtained over the same week.

3.2 APPARATUS

Frequency and duration data were recorded on a data logger designed and built at TSC. The device has a 32-key keyboard for recording up to 30 discrete events plus 2 error keys. The keyboard is connected to a digital tape recorder by a 10-foot cable. At the start of a data recording session the automatic timer is zeroed and the run begins. Whenever the watchstander begins one of the pre-specified activities, the observer pushes the appropriate labeled key. When the activity is completed, the

TABLE 3-1. DATA COLLECTION SCHEDULE FOR SFVTS

DATE	OBSERVATION HOUR	TIME
7/10	1	0930 - 1030
	2	1100 - 1200
7/11	3	1105 - 1205
	4	1630 - 1730
7/12	5	1000 - 1100
	6	1130 - 1230
	7	1500 - 1600
	8	1735 - 1835
7/13	9	0945 - 1045
	10	1505 - 1605

observer pushes the "stop" key followed by the activity key. The data logger can record start and stop times for up to 30 different activities.

3.3 PROCEDURES

3.3.1 Traffic

Information on vessel traffic in the system during periods of data collection was obtained from VTS records and from actual counts at the beginning and end of each session.

3.3.2 Watchstander Activity Data

An observer, seated to the side and slightly behind the watchstander, monitored and recorded his activities on the data logger. The activities recorded fall into the following categories: radio communications with vessels, handling the data cards, maintaining the radar displays and radio, other miscellaneous job-related and non-job-related activities. Within each category, both frequency and duration of various activities were recorded.

While these data were being recorded, a taped record of all radio communications on Channel 13 was being made and a second observer was monitoring these voice communications and making notes relating the components of the conversations to the activities of the watchstander.

Since the majority of a watchstander's time was used in performance of his duties, the time within each hour not specifically attributed to a labeled activity was classified monitoring, either of the radar or radio. This classification scheme was justified because any time a watchstander was looking away from his display system or engaged in social conversation the times were recorded.

3.3.3 Interviews

Nine individual interviews were conducted by one interviewer. Each interview generally followed the same format and covered the same topics but was open-ended. The interviewer and interviewee were seated comfortably either in the lounge area or in the public observation room. The interviewee was assured that he was not being evaluated in any way and that he would remain anonymous. All interviewees were asked to be completely candid, as their comments would be used as additional information in the evaluation and future improvement of the VTS system. The interviews proceeded as a conversation, with the interviewer observing the planned format but freely following up leads and probing interesting topics at his discretion. Each interview lasted approximately 1 hour.

3.3.4 Stress Questionnaires

A questionnaire designed to elicit information on subjective stress was administered to 12 watchstanders. The questionnaire contained 30 items (20 on body sensations, 10 on mood) that could be simply checked off by the subject. (A copy of the questionnaire appears in Appendix A). Each watchstander was individually approached and given a verbal description of the nature and purpose of the survey. If the watchstander agreed to participate in the stress survey, the experimenter handed him the written instructions to read immediately and answered any questions. After being assured that the instructions were understood, the watchstander filled out the questionnaire. The experimenter then gave him a packet of 16 copies of the questionnaire and asked that the watchstander complete one copy, four times daily for 4 days and mail them back to the experimenter in the envelope provided. To coordinate the results of the questionnaire with the work schedule, watchstanders were instructed to begin the survey on the first day of their next 3 consecutive days on duty. They were to complete the last four questionnaires on the first day of their break.

3.3.5 Critical Incident Interviews

A structured interview designed to gain information identifying sources of stress and possible remedies was conducted with the same 12 watchstanders that responded to the stress questionnaires. The interview dealt with three major topics: individual watchstander's recollection of a critical incident which he felt was stressful; the nature of his stress response to the incident; and possible changes in equipment, layout, and procedures which could alleviate the stress. (A copy of the interview form appears in Appendix B.) Watchstanders were temporarily relieved from duty to participate in both this interview and the stress survey. For those watchstanders who agreed to participate in the critical incident interview, the interviewer asked each question from the interview form and recorded the watchstander's responses. This interview generally lasted about 20 minutes.

4. RESULTS

4.1 TRAFFIC

Although SFVTS is a voluntary system, participation by the pilots and masters is virtually complete. In the radar coverage area, apparently all vessels subject to the Bridge-to-Bridge Radio Telephone Act, participate willingly. Except for an occasional tug without tow, participation in the VMRS area of the Sacramento and San Joaquin Rivers is also complete. This is corroborated by the radar returns in the Bay and from listening to Channel 13 for vessel reports in the Sacramento River. As an additional check, SFVTS ran a short study in which they stationed someone on several of the bridges along the river to record the name and time of sighting of each vessel observed. The report given to the TSC staff was that only a few tugs on the river had not reported in to the VTS, and these were on short trips entirely within the river. Clearly, then, user acceptance and participation in the SFVTS is high.

Traffic in the SFVTS area averages 4700 transits per month, of which nearly half are ferries. Table 4-1 shows the traffic load by vessel type for the first three quarters of fiscal year 1978. There were more than 975 tanker and freighter (commercial vessels) and 1100 tug transits in the system each month.

A traffic summary for the 4 days of data collection is presented in Table 4-2. There was an average of about 150 vessel transits per day in the system; 18 percent of these were tugs with tows, 13 percent freighters, 7 percent tankers, and about 55 percent were ferry transits. This average of 150 transits per day in 1978 is about the same as it was in 1973 but about three times what it was in 1972 according to a study done by Brown, Kim, McGregor, and Patton* for the Coast Guard. They reported a 1972 mean load of

*Brown, J.H.; Kim, M.; McGregor, D.; Patton, E., "Vessel Traffic System (VTS) Communications Study," Material on file at DOT/TSC.

TABLE 4-1. VESSEL TRAFFIC LOAD BY TYPE FOR FIRST THREE QUARTERS OF FY 1978

Vessel Type	Number of Vessels			Mean Traffic Per Month
	1st Qrtr	2nd Qrtr	3rd Qrtr	
Ferry (psngr)	6427	5772	6709	2100.9
Commercial	2845	2853	3097	977.2
Tug (w/tow)	2078	2515	2644	804.1
Tug (no tow)	1102	983	756	315.7
Ferry (Rail)	700	630	710	226.7
Dredge	199	856	18	119.2
Coast Guard	210	194	245	72.1
U.S. Navy	148	205	243	66.2
Explosive	8	4	3	1.7
Other	53	60	49	18.0
TOTAL	13770	14072	14474	4701.8

TABLE 4-2. VESSEL TRAFFIC LOAD BY TYPE FOR THE FOUR DAYS OF THE STUDY

Vessel Type	Date of Observation				Mean Traffic/Day
	7/10	7/11	7/12	7/13	
Commercial	37	25	34	27	30.8
(Freighter)	(23)	(16)	(21)	(18)	(19.5)
(Tanker)	(14)	(9)	(13)	(9)	(11.2)
U.S. Navy	2	3	1	2	2.0
Coast Guard	1	2	0	5	2.0
Tug (w/tow)	22	26	31	31	27.5
Tug (no tow)	8	8	1	6	5.8
Ferry (psngr)	73	76	79	68	74.0
Ferry (rail)	5	4	17	12	9.5
TOTAL	148	144	163	151	151.5

approximately 55 transits per day with 90 percent of the transits less than 2 hours long. The modal duration for these transits was 51-60 minutes long.

The vessel transit times for the 4 observation days ranged from 10 minutes to slightly more than 24 hours. A bar-graph showing the frequency of all transit durations in 10-minute intervals is presented in Figure 4-1. This graph includes data for all vessels except ferries over the 4 days both in terms of number and percent of total vessels. The median transit time was 1 hour, 52 minutes. The median time for ferries was 36 minutes and the combined median for all vessels was 1 hour, 10 minutes. The effective range was from 10 minutes to around 11 hours, with 90 percent of the transits under 6 hours, 30 minutes long. The median transit duration reported for April 1973 in the Brown, et al. study was also about 1 hour, 10 minutes.

Table 4-3 contains the data for the traffic load during the hours of observation. The range was from 5 to 12 vessels at any one time. The average traffic load at the start of an hour's session was 8.2 vessels and 8.4 at the end. The mean throughout the sessions was 8.3 vessels in the system at any given moment.

It is apparent that, at the time data were collected at SFVTS, traffic conditions were within the rubric of routine traffic conditions. From Table 4-1 the derived mean daily traffic for the first 3 quarters of FY '78 is 154.6 transits. From Table 4-2, at the time of data collection the traffic averaged 151.5 transits per day.

4.2 COMMUNICATIONS

In the analysis of the tape-recorded radio transmissions between VTS and the vessels, the amount of time spent in communications along with communication type was derived. These data are summarized in Table 4-4. These results show that watchstanders spend an average of 419.4 seconds, or 6.99 minutes per hour in communication with the vessels, and about 21 seconds per communication.

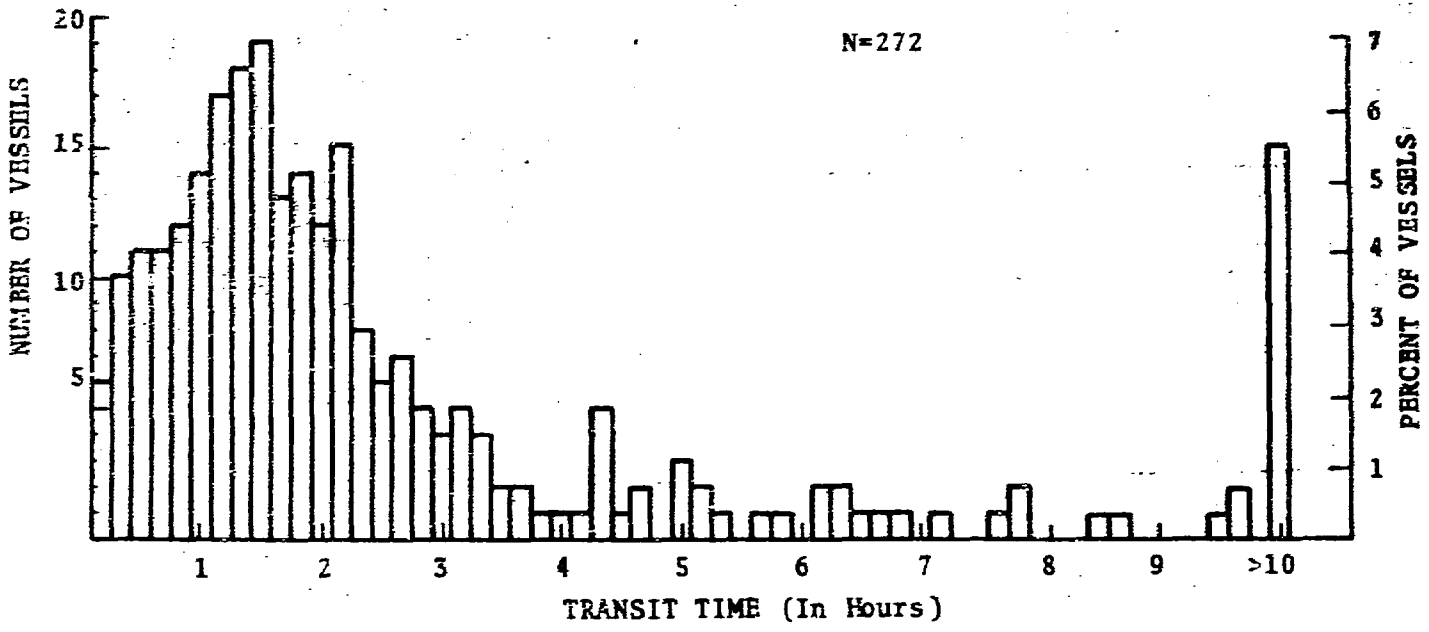

FIGURE 4-1. TRANSIT TIMES OF VESSELS IN SFVTS SYSTEM OVER FOUR DAYS OF THE STUDY (FERRY TRANSITS ARE EXCLUDED)

TABLE 4-3. TRAFFIC LOAD AT SFVTS DURING THE TEN HOURS OF DIRECT OBSERVATION

Date	Observation Hour	Time	Traffic At Start	Traffic At End
7/10	1	0930 - 1930	5	6
	2	1100 - 1200	5	6
7/11	3	1105 - 1205	7	7
	4	1630 - 1730	9	6
7/12	5	1000 - 1100	8	10
	6	1130 - 1230	10	9
	7	1500 - 1600	12	12
	8	1735 - 1835	11	6
7/13	9	0945 - 1045	8	11
	10	1505 - 1605	7	11

Although vessel reports of "getting under way" totaled 84 reports in 10 hours of observation with an average length of 24.8 seconds per communication, there was a difference between ferries and other vessels. Ferries reported leaving dock 48 times with a mean communication duration of 19.2 seconds; all other vessels totaled 36 reports with a mean duration of 32.2 seconds per communication. This difference is attributed to differences in information required by SFVTS. Ferries reported when they were departing giving only the vessel's name, destination, and ETA. In addition to this information, other vessels also reported such things as draft, cargo, and pilot on board. Another peculiarity of the ferries was that they did not report arrival at destinations; watchstanders noted arrival times by monitoring their movements on the radar displays.

TABLE 4-4. SUMMARY OF COMMUNICATIONS DATA BY TYPE AND OBSERVATION HOUR (DURATIONS GIVEN IN SECONDS)

Communication Type	Number of Communications per Observation Hour										Total	Mean Duration per Com.	Mean Com. length per hour
	1	2	3	4	5	6	7	8	9	10			
VESSEL-INITIATED													
Underway	4	8	8	11	6	10	11	6	10	10	84	24.8	208.0
Update (w/advisory)	1	–	–	–	–	1	4	1	1	1	9	25.0	22.5
Update (no advisory)	3	–	–	1	4	1	–	–	2	1	11	19.9	20.8
Exit System	–	4	–	2	3	1	2	1	1	1	15	23.4	35.1
Incomplete	1	1	1	–	–	–	–	–	–	–	3	40.7	12.2
No Response	1	–	1	–	–	–	–	–	–	1	3	2.7	0.8
Other	–	–	–	–	4	4	1	–	2	3	14	21.2	29.7
VES-INITIATED													
Advisory	–	–	–	1	2	–	9	1	5	2	20	19.5	39.0
Verification	–	–	–	–	1	2	3	–	3	1	10	11.6	11.6
No Response	–	–	–	–	2	8	–	3	2	1	16	2.9	4.6
Other	–	–	–	–	–	3	3	1	3	5	15	23.4	35.1
TOTAL	9	13	10	15	22	30	33	13	29	26	200	216.1	419.4

In the Brown study, it was reported that the average length of a transaction in April 1973 was 26.6 seconds. Compared to the 21-second average found in this study, it appears as though, with comparable traffic loads, the average length of a transmission has decreased about 20 percent. This drop of more than five seconds per transmission may be a function of different measurement techniques but with the light traffic of San Francisco there is little practical significance of the change.

The "incomplete" communications, referred to in Table 4-4, are those radio calls initiated by the vessel (three occurrences) where, for some reason, communications were either interrupted and not resumed or contact between vessel and VTS was lost. These incomplete calls did not occur in VTS-initiated communications. "No Response" calls were those initiated either by the vessel or VTS which were not answered by the other party. The VTS failed to respond three times. Such failures usually occur because the watchstander is busy with another communication. Reasons for vessels not responding are not known.

Sometimes, rather than issue separate advisories to two or more vessels which might be meeting in the near future, a watchstander would advise one of the concerned vessels about the others. He would then call the other vessels involved in the potential meeting and ask if they "copied" the previous advisory. This advisory verification occurred 10 times in the total sample period.

The "other" category included communications related to reports of, and requests for, information of various kinds.

Looking at radio communication as a whole, watchstanders spent an average of 11.6 percent of their duty time in communications with vessels in the system. In April 1973, the average percentage was 11.9.

Since SFVTS operates on Channel 13, the bridge-to-bridge channel, it would be expected that some of the communications heard by the watchstander would not be pertinent to his duties.

Channel 13 contained an average of 14.1 non-VTS-related communication transactions per hour totaling 2.4 minutes; hardly enough to cause much concern to watchstanders in performance of their duties.

There were two other types of job-related communications in which the watchstander was involved: talking on the telephone and conversing with the watch officer and other VTS personnel. Table 4-5 contains that information.

TABLE 4-5. MEAN FREQUENCY AND DURATIONS OF ALL WATCHSTANDER COMMUNICATIONS

Communication Type	Frequency per Hour	Total Time per Hour (in minutes)	% of Hour's time
Radio	20.1	7.0	11.6
Telephone	2.9	1.4	2.3
Job-related Conversation	10.9	2.6	4.3
Social Conversation	15.0	8.8	14.6
Total	48.9	18.8	32.8

The average time spent on the telephone was 1 minute, 21 seconds per hour. Most of the out-going calls were to the Marine Safety Office (MSO) to inform them of a tanker or freighter entering the system. There was an average of about one call per hour lasting 27 seconds. The total time allotted to out-going calls was 45 seconds per hour. There was an average of 2.4 incoming calls per hour, 45 percent of which the watchstander answered. These in-coming calls occupied 35.7 seconds per hour of the watchstander's time.

Conversations with other VTS personnel, the second duty-related communication category, occurred an average of 10.9 times per hour with a mean total duration of 2.6 minutes per hour. Much

of the time spent in conversation, however, was not directly job-related but was merely social conversation with others in the operations room. This occurred an average of 15 times per hour, taking a total of 8.8 minutes per hour (See Table 4-5).

4.3 VESSEL DATA CARDS

Watchstanders maintained the vessel data cards for two reasons: to know which vessels were in the system at any given time and for a record of traffic. In practice, the traffic was usually light enough and the watchstanders were experienced enough so that they knew the name and destination of each represented vessel return on the radar display without reference to the cards.

Placement of the cards on the working area in front of the watchstander reflected the vessels' locations in the system. Specific placements for cards varied with watchstanders, but generally, placing the cards to the left meant the vessel was outside the Golden Gate Bridge; the center represented the San Francisco Bay Area; to the right, south of San Mateo-Hayward Bridge; and above the table, on the radar display console, the radar coverage area north of the Richmond-San Rafael Bridge. For vessels in the VMRS area of the Sacramento and San Joaquin Rivers up to Sacramento and Stockton, cards were placed on a schematized representation of the river (the river status board) at their approximate location (See Figure 2-3).

Whenever a vessel radioed the VTS reporting entry into the system, either from sea or leaving a dock or anchorage, the watchstander would make up a card for that vessel and place it in the appropriate location. For vessels with multiple trips within the same day, such as ferries and some tugs, one card would serve for more than a single transit. When a vessel exited the system (i.e., docking, anchoring, or going to sea) the watchstander would make appropriate entries on the card and file it in the "out" stack. During transit there were several occurrences for which information would be entered on that vessel's card.

Watchstanders spent an average of 6 minutes, 35 seconds per hour attending to the cards. This attention is defined as the time from first picking up the card until it was placed back on the table or in the "out" file.

A summary of the data averaged over all runs is shown in Table 4-6.

TABLE 4-6. MEAN FREQUENCY AND DURATION DATA FOR HANDLING VESSEL DATA CARDS

Card Origin	Frequency per Hour	Total Time per Hour (in minutes)	% of Hour's Time
New Card File	5.4	2.9	4.8
Current Card File	15.2	2.2	3.7
Out Card File	4.7	1.5	2.4
Total	25.3	6.6	10.9

Creating a new card for a vessel entering the system typically required the watchstander to write down the vessel's name, type-code number, date, position, destination, pilot and draft (if appropriate), and any remarks felt necessary. This action occurred an average of 5.38 times per hour and took 31.9 seconds per card.

Handling the current cards, either to keep them current or to check a vessel out of the system, occurred with the greatest frequency, 15.23 times per hour, but took the least amount of time per incident, 8.75 seconds per card.

Whenever a ferry or a tug re-entered the system and a card was already made up, the watchstander would find the proper card in the "out" file and reinitiate it into current status. This occurred 4.7 times per hour.

The majority of the 18.8 seconds required to reinitiate each "out" card was time taken to locate the card. The only additional

data concerning quantity and type of vessels transiting the system were prepared, and the cards stored.

4.4 MONITORING

Four different watchstanders were observed for 15 minutes each, in an effort to establish visual monitoring behavior; that is, to determine how watchstanders divide their time between the five radar display consoles, the river status board, the vessel status board, the vessel data cards, and looking away from all the above.

By combining the four 15-minute observation periods into an hour, the following results were obtained: forty-two percent of the time, watchstanders were monitoring the radar displays; 27 percent, attending to the cards; 3 percent, inspecting the river and vessel status boards; and 28 percent of the time they were looking away from all the operations displays. Virtually all the time spent on radar monitoring was dedicated to central display (88 percent), showing the central San Francisco Bay area. (See Figure 2-5 for locations of radar displays). Five percent of the radar time was dedicated to display Number 4 and about two percent was spent on each of the other three displays. (Section 2.6.2 describes the displays on each of the radar repeaters.)

4.5 ALLOCATION OF DUTY TIME

By combining all of the activity categories and their associated durations a composite description of the percentage of time a watchstander typically spends in the component parts of his duties was achieved. This summary is presented in Table 4-7.

The most time-consuming activity performed by a watchstander was monitoring (45 percent of the total hour). Communication with vessels in the system was second highest of the job-related activities (11.6 percent). Writing on, reading, and filing the vessel data cards took 10.9 percent of an hour's time. Watchstanders spend a relatively small proportion of the time adjusting the radar and radio controls (2.2 percent) and this was generally

TABLE 4-7. PERCENTAGE OF TIME ALLOCATION FOR ACTIVITY CATEGORIES IN A TYPICAL WATCH

Activity	Percent of Total Time
Monitoring Displays	45.0
Radio Communications	11.6
Working With Cards	10.9
Job-Related Conversations	6.6
Adjusting Equipment	2.2
Consulting Written Material	2.2
Non Job-Related Conversations	14.6
Other Non Job-Related Activities	6.9
TOTAL	100.0

done when a relief watchstander took over. There were three major sources of written information to which the watchstanders referred during their watches: a clipboard containing expected arrivals and departures for the week, the status board with times of expected arrivals and departures for the day, and occasional miscellaneous messages coming in on the teletype. The time spent on these three references accounted for 2.2 percent of an average hour's watch.

Conversation with other personnel occupied 21.2 percent of the watchstander time with 6.6 percent being job-related and 14.6 percent, simply social conversation.

4.6 WATCH OFFICER

The watch officer, in the main, was involved with the supervisory functions of the watch. He monitored Channels 13 and 16 on his desk receiver, maintained official records of the day's activities, answered questions regarding procedures for the watchstander, handled watch rotations, and, occasionally, took over the

watchstander's position for brief spells. Since the activities observed by the TSC team were routine, the activities of the watch officer were, in turn, routine.

4.7 PERSONNEL INTERVIEWS

Nine interviews were conducted with two officers and seven enlisted men, representing an aggregate of 8 years of VTS experience. Additional information on the interviewees is summarized in Table 4-8.

The overall results of the interviews did not disclose any severe problems at SFVTS. Most of the personnel were satisfied with their job and felt that there was nothing difficult about their duties. The major criticism, however, seems to have its roots in this lack of difficulty; i.e., there was little to challenge the men, both officers and enlisted, alike.

The interview results can be divided into four basic categories; attitude toward SFVTS, comments on operations, use and adequacy of equipment, and discussions of situational variables.

4.7.1 Attitude Toward SFVTS

The responses to the basic question, "Do you like working at SFVTS?", were mostly favorable; 6 liked it, 3 did not. The reasons given for not liking the work were essentially the same, i.e., they were bored, there was no challenge, no job satisfaction, and no responsibility. (The last criticism was from a CPO who also complained that CPO's did the same job as E4's or E5's.)

The results were evenly divided on the question of VTS as a good career assignment; three felt it was, three felt it was not, and three gave qualified yes/no answers. Those that liked the VTS assignment and those with qualified responses stated that San Francisco was a good duty assignment and stressed the advantages of the shore duty at SFVTS and the good liberty afforded them. Those who thought VTS a poor career assignment stressed decreased opportunity for promotion and lack of challenge. The three who

TABLE 4-8. INTERVIEWS AT SFVTS

Interviews	Years in Coast Guard	Months at SFVTS	Years of sea duty	USCG School	Other Experience
Officer					
1	8	12	4	ASW,Leadership	
2	8	12	4	SAR	
Enlisted					
1	2.6	5	1.5	Radar	
2	18	10	9	Radar,Air Search	Instructor
3	13.5	18	7	Radar	
4	5	12	3	QM,Nav	Signalman
5	4	6	2	SAR	
6	8	2	5		
7	4	18	2	QM	Signalman

liked SFVTS duty and two of the three who were not sure, all commented that they would like another tour at SFVTS. (One of the "unsure" respondents was due to retire and did not respond to this question,) Also, four of the five would like a tour at another VTS.

Six felt that some form of vessel advisory service was necessary in the San Francisco Bay area and the three who felt it unnecessary thought it helpful to the users. And, given a VTS in the area, six thought the Coast Guard should operate it and three suggested civil service.

The present VTS was seen as meeting the area's need extremely well (7, excellent; 2, good) and all felt that except for a very few cases, the masters and pilots provided excellent cooperation.

The watchstanders all seem to feel that they are providing at least a useful, if not necessary, service and that they do it very well. The only complaint which was almost unanimous was that the general boating public does not appreciate the service. This they attribute to lack of information. Appreciation by masters, pilots, and the Coast Guard was felt to be good.

4.7.2 Operations

The actual operating procedures, including selection and training approach, were generally thought to be adequate. Most felt that nothing during training was particularly difficult to learn. Two things mentioned as causing some slight problem were learning to communicate over the radio and memorizing the ports and river geography. The mean reported time to qualify as a watchstander was 2.25 months (range = 0.5 to 4 months).

There were a few suggestions made to improve training. The following, made by four watchstanders, concerned the sequence of training:

1. "Standardize training for each section"
2. "Change sequence -- don't overload at first"

3. "Introduce publications last"

4. "Give some publications, then watch duty, then other material"

5. "Start listening to communications from Day 1; read regulations later."

Three interviewees felt that the present system was very good, and one suggested an official training officer.

The comments concerning personnel selection criteria reflect the interviewee's attitude toward the SFVTS. The more objective recommendations include good physical health, especially hearing and vision, and good "linguistic ability" and "speaking voice." The more subjective recommendations incuded selecting people who "want to come . . . know what to expect", who get along well with others, and, expecially people with a tolerance for boredom. One person suggested that VTS duty be opened up to more than radarmen and quartermaster rates.

Five of the nine interviewees liked the present watch schedule (mostly because they felt the liberty compensated for the long boring watches) even though six felt that the 12-hour shifts made them particularly tired even to the point of adversely affecting their perceptions of their efficiency (four respondents). Several stated that the transition between day/night shifts was difficult and that there should be longer runs at each shift.

The general attitude expressed (7 out of 9) about illumination and noise level in the operations room was that both were satisfactory, although there were four complaints that light entering the room when people opened the door to enter or leave the room caused the radar displays to wash out. The only real complaint about noise was related to difficulty in understanding radio communications when several other people in the room were talking.

The ventilation system in the room was considered only moderately adequate. Virtually all the interviewees complained that the operations room tended to be too hot during the day and too cold at night.

Most of the interviewees stated that none of the separate activities were difficult but three commented on slight problems maintaining the cards and matching them with the radar displayed returns.

4.7.3 Equipment

Within the operations room the radar system was the one aspect of the entire VTS system which was unanimously praised by the personnel at SFVTS. Typical descriptions were: "fantastic", "Best in the Coast Guard", "One of the niftiest I've ever seen".

Judging by the average rating of the other displays, all were rated high or medium relative to value and usage. The cards and the anchorage/arrival list were rated high on both parameters; and the VMRS plot, intra-bay movements list, and station weather report were rated medium as to both value and usage.

Two of the watchstanders and both watch officers interviewed had minor recommendations for rearrangement of the equipment. There were two recommendations to move the communications console closer to the watchstanders central location. Two others recommended that the five radar displays be arranged in a more semi-circular fashion rather than the linear positioning now in effect.

4.7.4 Situational Variables

The average daily traffic estimate for the nine interviewees was 9.2 vessels per hour during the day (the range was 4-14). When asked how many vessels they thought they could comfortably handle before becoming overloaded they responded with estimates from 15 to 30 per hour (mean: 21.8). In response to queries concerning procedural changes during periods of high traffic density six reported they had not experienced particularly heavy traffic requiring changes in procedure. The report of the others was that a second watchstander was added to cover the area where the added congestion was; either outside the Golden Gate Bridge or in the river to Sacramento and Stockton. Occasionally, with a SAR opera-

tion in progress or a particular vessel needing assistance, a man will be added to aid in the specific problem.

Boredom was again cited as a major criticism in response to questions concerning areas in need of improvement and situations which make the job difficult. The most common attitude expressed was, in effect, if boredom could be alleviated everything would be great at the center. Other than boredom, however, one watchstander commented that several of the watch officers assumed too much control and act as though "they're running the bay." Another interviewee stated that the present watch schedule was the situation most in need of improvement.

The final two specific questions concerned the relationship between the VTS and vessels involved, or potentially involved, in an incident. The first question was, "How did the VTS significantly aid in the resolution of a conflict?" Eight respondents suggested helping in the navigation of vessels under adverse conditions; seven, in relaying messages; and three said helping in SAR and in detecting problems like noticing vessels dragging anchor and discovering small vessels adrift.

The second question regarding situations made worse by the VTS, received many different responses, none of which were critical to marine safety; the comments reflected only aspects of the current operation which watchstander felt could improve operations in general.

Sample comments were that the frequency of advisories should be decreased, that more flexibility was needed in allowing deviations from standard procedures and rules, and that some watch officers antagonize pilots by being unnecessarily authoritative.

When asked for any further comments, only two interviewees had anything else to offer and each of them reiterated the underlying theme of the entire interview session, there is a "need to alleviate boredom" and "the problems here are not in doing the job but in the lack of stimulation."

4.8 STRESS QUESTIONNAIRES

The stress questionnaires were administered to 11 watchstanders at SFVTS and six of the follow-up questionnaires have been returned as of this writing. Basically the findings show no appreciable stress at SFVTS. There were only two categories in both the somatic and mood indices which reflected any stress at all: aching or burning eyes and difficulty in staying awake, from the somatic index, and tired and drowsy, from the mood index. All four of these items are somewhat related and they all averaged closer to a response of "none" than to "moderate."

Watchstander reports of aching or burning eyes are commonly reported stress symptoms at each of the VTS's. But though it is a common response it is by no means trivial. Watchstanders at SFVTS spend a considerable amount of time monitoring radar displays in a condition of low ambient illumination, both factors in causing eye-strain. This eye-strain, in turn, is fatiguing and could induce a reduced vigilance in monitoring.

Those reports relating to drowsiness probably relate to the overall boredom present at the center. The low traffic load, high degree of user cooperation, excellent radar coverage, and the large, open harbor, all contribute to reduced stress and, perhaps, increase boredom for the watchstander. This is often the case when a system is successfully fulfilling its assigned task.

The follow-up reports by six watchstanders reflected this identical pattern, i.e., increases over days and within a watch for eye-strain and for drowsiness and tiredness. But as with the initial survey, the median response was considerably below "moderate."

4.9 CRITICAL INCIDENT INTERVIEWS

Eleven watchstanders with an average age of 26 years, time in service of 7.2 years, and time at the VTS of 15.5 months participated in the critical incident interviews. During each watchstander's break period he went to the lounge with the interviewer

for the 20-minute interview.

The general result again was that there was no appreciable stress at SFVTS but there was marked boredom during the break periods. The comments concerning changes in equipment, layout, and procedures reflected a satisfaction with the status quo. Table 4-9 summarizes the responses from the 11 watchstanders.

It can be seen that 7 of the 11 reported no on-watch stress but 9 reported off-watch boredom. The few stressor sources which are noted are relatively minor. Seven to nine watchstanders are satisfied with the situation as it is now and those who suggested changes are divergent in most of their ideas. The exceptions are that three interviewees suggested rearranging the radar displays in a semi-circle, two added that the two outer displays should be deleted. The only other suggestions by more than a single individual were to reduce the officer complement and standardize operations between watch sections.

The critical incidents reported by the interviewees (Table 4-10) are varied both in the events recalled and in their concomitant stressors. There were no indicated changes in equipment or procedures which could have prevented these occurrences.

TABLE 4-9. RESULTS FROM CRITICAL INCIDENT INTERVIEWS

A. Stressor sources	FREQUENCY
No on-watch stress	7
Boredom off-watch, but on duty	9
Boredom on watch	3
Between sections rivalry	3
Watch Officer staring over shoulder	3
Excessively long weekend work schedule	1

B. Changes suggested to reduce or eliminate stress sources:

1. Equipment	
No changes	9
Drop two outer radar displays	2
Repair available equipment	1
2. New Equipment	
No changes	8
Require improved card system for increased traffic	1
Upriver radar	1
Low light-level TV cameras	1
3. Layout	
No changes	7
Arrange radar screens in arc around watchstander (dropping two end radar displays)	3
Convert communications console to desk-mounted controls	1
4. Procedures	
No changes	7
Standardize between sections	2
Change to 8-hour shifts	1
Require tugs to call-in more often	1
5. Personnel	
No change	6
Reduce officer complement	2
Fewer needed on each section	1
Iron out some interpersonnel difference	1
Some personnel selection suggestions	1

TABLE 4-10. REPORTED CRITICAL INCIDENTS AND CORRESPONDING STRESS SOURCES

Incident	Stressor	Sensation	Duration
3 watchstanders reported no incidents.			
Two vessels passed beneath the Oakland Bay Bridge under the same span.	Could not see except by walking outdoors and looking. Weather good.	Some anxiety	15-20 min.
Outbound Navy ship followed by a tanker was meeting an inbound tanker at the Golden Gate Bridge in fog	Inbound vessel strayed into outbound lane; possible collision.	Excited	15-20 min.
Two vessels began dragging anchor	No one seemed concerned about the potential danger.	Racing heart beat	10 min.
First training period on watch.	New responsibilities.	Anxious	2-3 min.
Four of five vessels calling at same time.	Some pilots angry at delay.	Felt pressured	5-10 min.
Tug passing outbound vessel. Tug operator slow to respond and gave inaccurate information.	Tug operator uncooperative.	Mad	15 min.
Outbound vessel sideswiped by sailboat. Two killed.	Unnecessary tragedy.	Felt he ought to have found a way to avert the tragedy.	Rest of watch
Lady screaming over Channel 16 that her husband had fallen overboard and she did not know how to operate the 35-foot power boat.	SAR did not seem to be responding rapidly enough; someone else pulled the guy out.	Angry that she did not know how to operate the boat. Husband had not taught her. SAR slow.	Half hour

5. DISCUSSION

5.1 TRAFFIC

The number of vessel transits per day has remained fairly constant in the SFVTS area since 1973, at around 150. The mean number of vessels in the system at any given time, for the hours of data collection, was about eight. And, since there were no unusual occurrences during the hours of observation at SFVTS, it is safe to state that data were collected during routine operations.

With an average of only eight active vessels in the system at any given time one would expect that present SFVTS procedures could easily monitor traffic in the VTS area. If, however, traffic were to increase to a level of 20 or more active vessels at a time, watchstanders would find monitoring traffic extremely difficult. Since watchstanders track vessels by memory, aided by approximate card arrangements, heavy traffic loads would overload the memory capabilities of all but the most skilled watchstander.

5.2 WATCHSTANDER ACTIVITES

5.2.1 Communications

Summarizing the analyses for communications in this study and comparing them with similarly derived results from the Brown study on communications yields the data shown on lable 5-1. The two majo. differences between the two studies is a 5-second drop in the average length of a communication and an increase of four communications per hour. So in spite of relatively identical traffic loads, the number of communications has increased slightly and the average length per communication has decreased. As long as the quality of the service does not suffer, this trend toward shorter radio transactions is desirable.

TABLE 5-1. COMMUNICATIONS SUMMARY FOR SFVTS BASED ON FY 1973 AND FY 1978 DATA

SUMMARY	1973*	1978
Time spent in communications	7.16 min/hr 11.64 % Total	6.99 min/hr 11.93 % Total
Length of a communication	26.6 seconds	21 seconds
Number of communications/hr.	16.15	20

*Based on the Brown study.

5.2.2 Vessel Data Cards

Maintenance of the cards occupies about 11 percent of the watchstanders' time and is necessary, both for permanent records and for identification of the radar returns on the display. Since both of these functions are important in VTS operations, the present card system under the present work load is completely adequate. The only problem is with the large amount of storage area required to save these cards for possible future reference. Also, any person or agency requiring access to the old cards has a formidable task in sorting the cards to obtain the desired information. The summaries (daily, monthly, quarterly and annual) compiled by the center, however, provide good general statistics on traffic.

5.2.3 Monitoring

The single activity occupying the greatest proportion of the watchstanders' time (45 percent) was monitoring the system. This time was mostly directed toward the five radar displays and almost exclusively to the central display. The amount of time any watchstander spends on monitoring is a function of time required by other demand activities (most notably, communication and handling data cards), accessibility of the different monitoring devices,

and the watchstander's incentive. Clearly, as the time requirements of the demand activities increase, the amount of time available for monitoring will decrease. But at SFVTS, for the conditions extant at the time of this study, there was no such problem.

There may be a potential problem with monitoring the two outer radar displays (Radar displays 1 and 5 in Figure 2-5). Because of the linear juxtaposition of the five displays, the watchstander can view the two extreme radars only by moving to one end of the row or the other. This tends to create a situation where traffic around the outer buoy "SF" (Radar 1) and traffic in the lower San Francisco Bay and the restricted traffic area (Radar 5) may not be monitored as closely as it should. However, several of the watchstanders indicated that they felt these two radar displays were unnecessary and should be deleted. Further study is required to resolve this situation.

5.2.4 Allocation of Duty Time

The manner in which watchstanders alloted their time to the various duties (see Table 4-7) reflects a system which operates very well without excesses of stress or overloading. This can be seen by noting that all of the demand activities are easily met (radio, 11.6 percent of the time and working with cards, 10.9 percent), 45 percent of the time is dedicated to monitoring, and over 20 percent of this time is available for more social, non-job-related activities. As traffic load increases, this latter 20 percent is readily available for job-related activities.

5.3 EQUIPMENT AND WORKSPACE

Basically, the watchstanders were well satisfied with the equipment of SFVTS, especially the radars. There were two suggestions by the watchstanders which were consistent with impressions of the TSC team's observations which would ease operations; arrange the five radar displays in an arc around the central display and consolidate the communication console closer to the central position to facilitate channel selection and adjustments.

There was one problem observed by the TSC team and reported by the watchstanders; when the door to the operations room is opened, the incoming light washes out Radar Displays 4 and 5. One way to avoid this problem is to shield the screens but, since the operations room is already small and any shield would inhibit mobility, expecially to the radio console, this is not very practical. A possible solution would be to construct a shielded entryway in the hall.

5.4 TRAINING, STAFFING AND SCHEDULING

The training program at SFVTS appeared to be sufficient for the needs of the area but several of the watchstanders felt that the sequence of training events should be changed and that a specific training officer should be assigned to the VTS. At this point, the only appropriate recommendation concerning training is that it should be studied more at all centers to more fully understand the strengths and weaknesses of each VTS's program.

The 12-hour watch scheduling was considered desirable by virtually all watch personnel, largely because of the advantageous liberty afforded them. This preference was expressed in spite of comments by some watchstanders, and indications from the stress questionnaires, that they felt fatigued to the point of reduced efficiency by the last hour or two of the watch. Again, more study is required before any recommendations on shift organization can be made.

The SFVTS is making an effort to provide the opportunity for the watchstanders to pursue training in their career fields. This is a commendable procedure and should work to help alleviate the boredom that was expressed by the watchstanders. This on-and off-watch boredom can be dealt with only so far by official procedures and actions by SFVTS however, and ultimately must be resolved by the watchstanders themselves.

5.5 ENVIRONMENT AND STRESS

There was no appreciable stress noted at SFVTS but there were a few minor stress related environmental situations which were less than ideal. Reports of aching and burning eyes were common among the watchstanders. There are several possible conditions any or all of which may explain the phenomenon. Working in a room with a general, low ambient light level with a few bright spots can easily cause eye fatigue. Lack of proper air circulation (a condition reported by several watchstanders) coupled with heavy cigarette smoke (often observed in the operations room) would clearly lead to eye irritation. The third possible contributing condition is the general fatigue of a 12-hour watch. However, since radar watches are generally 2 hours on, 2 hours off there should be enough time to recover between watches. These are hypotheses which must be tested in the future.

6. RECOMMENDATIONS

The overall impression, garnered from analysis of the data and attitudes of watchstanders, is that SFVTS, during routine operations, is a smoothly running operation, providing an advisory service to its users in an efficient manner. The major problem is the boredom of watchstanders who are on duty but off watch.

The recommendations put forward, based on these data, are as follows:

1. Study the efficacy of the present work schedule, both shift hours and day/night rotation. (2.4.4, 4.7.2)
2. Improve heating/cooling/circulation of air in operations room. (4.7.2)
3. Explore methods to light-shield radar displays. (4.7.2)
4. Standardize SOP for all watch sections, with special emphasis on exceptions to basic traffic patterns. (2.3.3, 4.7.4)
5. Examine training procedures to ease introduction to new watchstanders. (2.4.3, 4.7.2)
6. Continue and expand emphasis on career training and education for VTS personnel. (2.4.5, 4.7.1)
7. Examine effects of reorienting radar consoles in an arc around central watchstander position. (2.6.5, 4.7.3)

APPENDIX A

STRESS QUESTIONNAIRE

U.S. Department of Transportation
Transportation Systems Center
Kendall Square
Cambridge MA 02142

This survey is designed to assess the physical and psychological effects you experience in connection with your work as a U.S. Coast Guard Vessel Traffic Services watchstander. Under no circumstances will your answers become a part of your personnel file or in any way affect your status in vessel traffic services work. You will be assigned an identification number so that all responses from each individual can be kept together. These data will be stored at the Transportation Systems Center until summarized. At that point there will be no further need to identify an individual's data and all forms will be destroyed.

Your task is to rate the degree of physical or psychological efforts you are experiencing at the time you fill-out the rating form. You are to complete the rating form four times each working day: Just before beginning a shift, during a break or lull about half way through a shift, at the end of the shift, and at home at least three hours after a shift. You are to do this for one week.

Your specific task on each form is to rate the degree of physical or psychological effects you are presently experiencing for each item from none through severe by marking an X anywhere along the line as illustrated in the examples below. Suppose at the time you are completing the form you do not have a headache, then mark the item as shown:

1. Headache: X

None Moderate Severe

Suppose you do have a headache at the time you are completing the form, then depending upon its degree you might mark the item as shows:

1. Headache: X

None Moderate Severe

Your cooperation is greatly appreciated. Thank you.

STRESS QUESTIONNAIRE

Complete only these first two lines.

I.D.: _____ DATE: _____ SHIFT: _____

TIME OF DAY	PRE	DURING	POST	HOME
TRAFFIC LOAD:	_____	_____	_____	_____
WEATHER:	_____	_____	_____	_____

Each line below represents a scale of symptoms you might experience ranging from none to severe. For each item below please mark an (X) anywhere along the line corresponding to the degree of symptom you are now experiencing. (You may go beyond the ends of the line if you wish.)

1. Headache: None Moderate Severe
2. Constipation: None Moderate Severe
3. Sweating: None Moderate Severe
4. Twitching muscles: None Moderate Severe
5. Dizziness: None Moderate Severe
6. Poor appetite: None Moderate Severe
7. Chest pains: None Moderate Severe
8. Loose bowels: None Moderate Severe
9. Loss of temper: None Moderate Severe
10. Difficulty in breathing: None Moderate Severe
11. Aching or burning eyes: None Moderate Severe

12. Indigestion or heart burn: None — Moderate — Severe

13. Difficulty in staying awake. None — Moderate — Severe

14. Stiffness or body tenseness: None — Moderate — Severe

15. Bothered by distracting noise: None — Moderate — Severe

16. Nausea or sick to your stomach: None — Moderate — Severe

17. Asthma: None — Moderate — Severe

18. Insomnia: None — Moderate — Severe

19. Backache: None — Moderate — Severe

Each line below represents a scale of moods you might feel ranging from none to severe. For each item below please mark an (X) anywhere along the line corresponding to the degree of mood you feel at the present moment. (You may go beyond the ends of the line if you wish.)

1. Worry: None — Moderate — Severe

2. Uncomfortable None — Moderate — Severe

3. Tense: None — Moderate — Severe

4. On edge: None — Moderate — Severe

5. Irritable: None — Moderate — Severe

6. Fidgety: None — Moderate — Severe

7. Depressed: None — Moderate — Severe

8. Upset:

None — Moderate — Severe

9. Anxious:

None — Moderate — Severe

10. Tired:

None — Moderate — Severe

11. Drowsy

None — Moderate — Severe

APPENDIX B

CRITICAL WATCHSTANDER STRESS INCIDENTS: STRUCTURED INTERVIEW

Preface:

The survey administered at this Vessel Traffic Service Center revealed the presence of stress. The purpose of this interview is to uncover the sources of that stress and to assess the form of these stresses. Do you agree that there is stress present at this VTS Center?

Yes No.

A. General:

1. Sources: Please indicate those sources of stress which in your opinion exist at this VTS Center.

2. Changes: What changes do you suggest be implemented to reduce or eliminate these sources of stress?

Equipment:

New Equipment:

Layout:

Procedures:

B. Descriptors:

1. Stress responder: In comparison to others, rate your response to stress on the following scale:

Much more than others | Same as others | Much less than others

2. Stress response: Please describe those stress responses which you usually experience?

3. Motivation for VTS duty: After this tour of duty expires, what would motivate you to continue on as a watchstander in the U.S. Coast Guard?

C. Incident:

Please describe a recent stressful incident occuring while you were standing watch at the VTS center. This incident need not be of major proportions, only one in which you experienced stress.

Description:

How recently did this event occur?

What made this a stressful incident?

What stress sensations did you feel?

For how long after the incident did you feel this way?

What changes in the equipment, layout, or procedures would you suggest to prevent such an incident from recurring?

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